

Heuristics and Biases in Probability Judgment

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Heuristics and Biases · Part 1 of 3

Lecture 1



Part

00

WHAT YOU WILL LEARN

- Explain what a **heuristic** is and why the mind relies on them
- Recognise the three classic heuristics: **availability, representativeness, anchoring and adjustment**
- Spot the biases each one creates, with everyday and business examples
- Correct simple probability errors, such as conjunctive and disjunctive events
- Judge fairly whether human probability judgment is really "so poor"

Part

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WHY PROBABILITY JUDGMENT MATTERS

- Decisions under risk need **probabilities**: will the project overrun, will the supplier fail, will demand rise?
- Often no statistical data exist, so the numbers come from **judgment**
- Psychologists have studied for 50 years how good those judgments are
- This chapter summarises what they found, and what managers can do about it

Bad probabilities in, bad decisions out. Even a perfect model cannot rescue a biased estimate.

Part

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ROADMAP FOR THIS DECK

- 1 **Availability** Judging by how easily examples come to mind
- 2 **Representativeness** Judging by how typical something looks
- 3 **Anchoring and adjustment** Starting from a number and adjusting too little
- 4 **Other biases and a verdict** Wishful thinking, covariation, and is judgment really poor?



Part

01

HEURISTICS AND BIASES

1. What is a heuristic?
2. The three main heuristics

Part

01

WHAT IS A HEURISTIC?

- A **heuristic** is a simple mental strategy that copes with a complex judgment
- It saves effort and is often good enough
- But it can produce **systematic** errors, called **biases**
- Systematic means the errors lean in a predictable direction, not randomly

Heuristic = shortcut. Bias = the predictable mistake the shortcut sometimes causes.

Tversky and Kahneman showed that people estimate probabilities with a few simple heuristics.

Their work began in the early 1970s and shaped modern decision research.

Part

01

THE THREE MAIN HEURISTICS

1

Availability Probability = how easily examples come to mind

2

Representativeness Probability = how well something fits a stereotype or a pattern

3

Anchoring and adjustment Start from an initial value, then adjust, usually too little



Part

02

THE AVAILABILITY HEURISTIC

1. Availability in action
2. What makes an event easy to recall?
3. Bias 1: ease of recall is not probability
4. Answer: ranking of causes of death
5. Bias 2: ease of imagination is not probability
6. Bias 3: illusory correlation

Part

02

AVAILABILITY IN ACTION

The scenario

You are asked the chance that a shop will fail within a year. You search memory for shops that closed, or imagine ways it could happen. If examples come quickly, you judge failure to be likely.

What it shows

People judge probability by **how easily events come to mind**, not by how often they truly occur.

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WHAT MAKES AN EVENT EASY TO RECALL?

- 1 **Vivid** Striking, dramatic events stay in memory
- 2 **Recent** Fresh events crowd out old ones
- 3 **Emotional** Events that touched us feel bigger
- 4 **Media-covered** Headlines make rare events feel common

Availability can be reliable, since frequent events are usually easier to recall. The trouble starts when ease and frequency separate.

BIAS 1: EASE OF RECALL IS NOT PROBABILITY

- UK study (1996): elderly people were **rarely** victims of violent crime
- Yet the elderly believed their risk of attack was frighteningly high, because attacks make headlines
- US studies: deaths by animal bites and stings were **grossly overestimated**
- People rated accidents and disease as equally likely killers. In reality, disease kills **15 times** more people
- Estimates followed recent newspaper reports, and also stories from personal social circles

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TEST YOUR JUDGMENT

Q1. What percentage of people in the US were victims of a violent crime in 2023, according to official statistics?

ANSWER

0.36%

Victims of violent crime, US, 2023

Source: FBI National Incident-Based Reporting System.
Most people guess far higher, because crime is heavily reported.

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TEST YOUR JUDGMENT

Q2. Rank these causes of death for a random US citizen, from most to least likely.

A

Accidental opioid overdose

B

A fall

C

Gun assault

D

Cataclysmic storm

E

Dog attack

F

Walking or crossing the street

ANSWER: RANKING OF CAUSES OF DEATH

Rank	Cause	Chance (National Safety Council, 2023)
1	Accidental opioid overdose	1 in 57
2	A fall	1 in 91
3	Gun assault	1 in 238
4	Walking or crossing the street	1 in 471
5	Cataclysmic storm	1 in 39,192
6	Dog attack	1 in 44,499

Dramatic events (storms, dog attacks) feel more likely than quiet, common ones (falls).

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BIAS 2: EASE OF IMAGINATION IS NOT PROBABILITY

The scenario

A civil engineer easily imagines everything that could delay a project: strikes, weather, geology, supply failures. The result can be a gross **overestimate** of the risk of overrun.

What it shows

The reverse also happens: dangers that are **hard to imagine** get underestimated.

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BIAS 3: ILLUSORY CORRELATION

The scenario

A factory manager suspects foreign suppliers are less reliable. Cases of "foreign and defective" are easy to recall. The many reliable foreign deliveries, and defective domestic ones, are not.

What it shows

Preconceptions inflate how often two events seem to occur together, and can **persist even against contradictory evidence**. This matters when estimating conditional probabilities.

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THE REPRESENTATIVENESS HEURISTIC

1. How representativeness works
2. Bias 1: ignoring base rates (Tom W.)
3. The identified victim effect
4. Random sequences contain runs
5. Why this matters in forecasting
6. Bias 3: expecting chance to correct itself
7. Bias 4: regression to the mean

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HOW REPRESENTATIVENESS WORKS

- Is Peter, met at a party, a salesperson? You compare him with your **stereotype** of a salesperson
- Was this faulty circuit board made in Pittsburgh? You ask whether it **looks like** their typical output
- Is this sales graph just random? You compare it with your picture of **randomness**
- The more typical the fit, the higher the probability you assign

The catch: similarity is not the same as probability.

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BIAS 1: IGNORING BASE RATES (TOM W.)

The scenario

Tom W. is described as intelligent, orderly, mechanical, and lacking sympathy. One group was told he came from 30 engineers and 70 lawyers. Another group was told 70 engineers and 30 lawyers.

What it shows

Both groups gave **essentially the same** probability that Tom is an engineer. They ignored the **base rate** and used only the description.

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TEST YOUR JUDGMENT

Q3. Eight percent of interviewees at a company have a criminal record. Notes on Jim X: scruffy, no eye contact, weak handshake, a scar, unfriendly. What is the probability that Jim has a criminal record?

ANSWER

8%

The base rate says about 8%

The description is unreliable and hardly informative. Estimates far above 8% show that vivid detail overpowered the base rate.

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THE IDENTIFIED VICTIM EFFECT

1

CHARITY A named child Adding a name and a photo to a sick child appeal raised donations

2

MEDICINE A known patient Physicians spent more time and resources on a known patient than on unknown ones

3

EDUCATION A specific student Principals bent the rules more when the case was one student, not a group

Individual detail beats statistics. We will pay more to save a "real" person than a "statistical" one.

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RANDOM SEQUENCES CONTAIN RUNS

38 of 64

Random sequences contain runs

Six coin tosses give 64 equally likely sequences. **38** of them contain three or more identical results in a row.

H-H-H-T-T-T is exactly as likely as T-H-H-T-H-T. Real randomness looks streakier than we expect.

WHY THIS MATTERS IN FORECASTING

- People expect random data to alternate a lot and to have short runs
- In an experiment, an **alternating** cost series was judged random, while a truly **random** series seemed to contain patterns
- Managers then over-react to the latest sales or cost figure
- Reading patterns into noise leads to wasted reactions and poor forecasts

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TEST YOUR JUDGMENT

Q4. A box has 100 bulbs, half defective. Six are drawn at random. Which sequence is most likely?

A defective, OK, defective, OK, defective, OK

B defective, defective, defective, OK, OK, OK

C OK, OK, defective, OK, defective, defective

ANSWER

All three are equally likely

Option C looks most "random", which is why many choose it. Looking random is not the same as being more probable.

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BIAS 3: EXPECTING CHANCE TO CORRECT ITSELF

- After a long run of heads, a tail feels "overdue"
- Newspapers advised lottery players to pick "cold numbers" that had not been drawn for a while
- Coins and lotteries **have no memory**, so past results do not create a debt
- A driver with 40 accident-free years is **not** more likely to crash in the next 5 just to balance the record

Q5 and Q6 in the book: the driver reasoning is false, and cold numbers do not improve your chances.

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BIAS 4: REGRESSION TO THE MEAN

- 1 **Extreme result** A very tall father, a record sales month, a perfect landing
- 2 **Luck helped** The result reflects skill plus a lucky mix of chance factors
- 3 **Next time** Chance rarely repeats, so the result moves back toward average

Galton found tall fathers tend to have shorter sons, and short fathers taller sons.

Part

03

THE FLIGHT INSTRUCTORS

The scenario

Instructors praised trainee pilots after very smooth landings and criticised them after rough ones. Smooth landings were usually followed by worse ones, and rough landings by better ones.

What it shows

Regression to the mean made criticism **look** more effective than praise. The instructors drew the wrong conclusion.

Part

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TEST YOUR JUDGMENT

Q7. Beer sales are driven by chance factors. A record 1.2 million cans were sold in the first week of August. Next week will be:

A Higher

B About the same

C Lower

ANSWER

Lower is most likely

An exceptional week is probably helped by luck (weather, big matches). With no other information, expect sales to move back toward average.

Part

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BIAS 5: THE CONJUNCTION FALLACY (LINDA)

The scenario

Linda, 31, is outspoken, bright, studied philosophy, and cared about social justice. Which is more likely? (a) Linda is a bank teller. (b) Linda is a bank teller active in the feminist movement.

What it shows

Almost **90%** chose (b). But two things together can never be more probable than one alone. People judged which option **fits** Linda better.

Part

03

THE CONJUNCTION RULE OF THUMB

- $P(A \text{ and } B)$ can **never** exceed $P(A)$ on its own
- Your boss is more likely to be female than to be female **and** married
- Your car is more likely to be red than red **and** under two years old
- Adding detail makes a story feel **more** plausible, but makes it **less** probable

Relevance for planning: a richly detailed scenario is more vivid, yet each added detail lowers its true probability.



Part

04

ANCHORING AND ADJUSTMENT

1. How anchoring works
2. Bias 1: insufficient adjustment
3. Conjunctive events are overestimated
4. Conjunctive events in planning
5. Disjunctive events are underestimated
6. Bias 4: overconfidence

Part

04

HOW ANCHORING WORKS

- 1 Start** Begin from an initial value: last year, a quoted price, a random number
- 2 Adjust** Move up or down to reach your estimate
- 3 Stop early** Adjustment is **insufficient**, so the answer stays close to the anchor

Part

04

BIAS 1: INSUFFICIENT ADJUSTMENT

The scenario

Participants spun a wheel of fortune, then estimated the percentage of African nations in the United Nations. Their answers were pulled toward the random number from the wheel.

What it shows

Even an **obviously irrelevant** anchor moves estimates. Being made angry can weaken the effect.

Part

04

TEST YOUR JUDGMENT

Q10. Was the population of Egypt in 2023 higher or lower than 50 million? Now estimate it.

ANSWER

114.5M

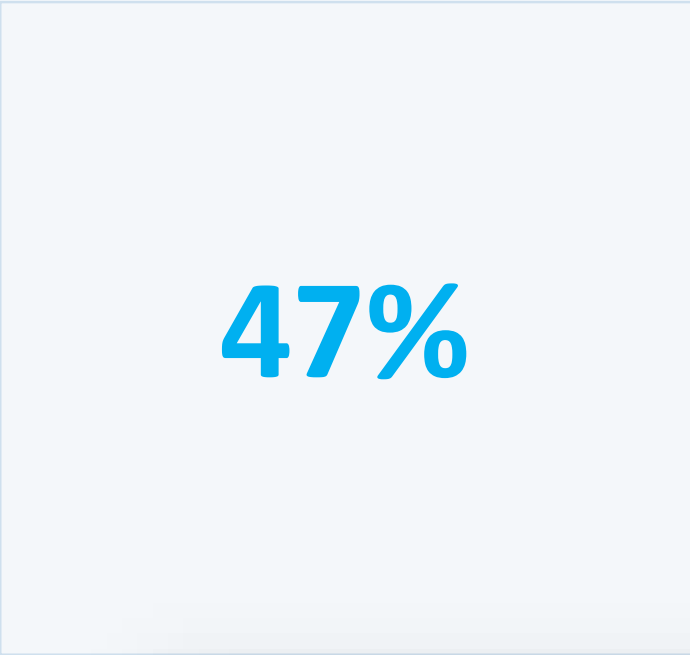
114.5 million

The population of Egypt in 2023 (source: WHO). If your estimate stayed close to 50 million, the anchor worked on you.

Part

04

CONJUNCTIVE EVENTS ARE OVERESTIMATED



47%

Conjunctive events are overestimated

A safety system has **150** independent components, each 99.5% reliable. All must work. The whole system works only **47%** of the time.

People anchor on 99.5% and adjust too little. Projects with many steps, all of which must succeed, are usually more risky than planners think.

CONJUNCTIVE EVENTS IN PLANNING

- A new product launch or a construction project is a **chain** of steps
- Every step may look highly likely, say 90%
- Seven independent steps at 90% each give only about **48%** overall
- This is one reason projects finish late and over budget

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DISJUNCTIVE EVENTS ARE UNDERESTIMATED

40%

Disjunctive events are underestimated

An office has 10 people, each with a 5% chance of leaving this year. The chance that **at least one** leaves is 40%.

Small risks add up. Risk assessment often involves "at least one thing goes wrong", exactly where we underestimate.

Part

04

TEST YOUR JUDGMENT

Q13. Give a best estimate and a 90% confidence range for quantities such as the air distance from Moscow to Cape Town or the length of the Danube.

ANSWER

Most people are overconfident

Ranges meant to include the truth 90% of the time usually include it far less often. Estimators anchor on their best guess and adjust the limits too little.

BIAS 4: OVERCONFIDENCE

- Estimators state ranges that are **too narrow**
- Alpert and Raiffa asked for 90% ranges. The true value fell outside far more than 10% of the time
- Cause: anchor on the best estimate, then adjust the lower and upper limits insufficiently
- Example: a maintenance manager gives optimistic and pessimistic overhaul times that are too tight

Overconfidence makes plans too rigid. Ask for wider ranges and check how often past ranges were right.



Part

05

OTHER BIASES

1. Desirable outcomes seem more probable
2. Biased assessment of covariation
3. Why covariation goes wrong

DESIRABLE OUTCOMES SEEM MORE PROBABLE

- People often see **good** outcomes as more likely than bad ones: **optimism bias**
- Students estimated their own chances of positive events as better than their classmates
- Wishful thinking can distort risk estimates in business cases and forecasts
- Watch for it when the estimator has a stake in the result

Part

05

BIASED ASSESSMENT OF COVARIATION

Is the symptom related to the illness?

	Illness present	Illness absent
Symptom present	12	6
Symptom absent	6	3

$P(\text{illness} \mid \text{symptom}) = 12/18 = 2/3$. $P(\text{illness} \mid \text{no symptom}) = 6/9 = 2/3$. No relationship at all.

WHY COVARIATION GOES WRONG

- Many people conclude the symptom **is** related to the illness
- They look mostly at the cell where **both** are present (12)
- The other three cells matter just as much
- To judge a relationship, compare the **conditional probabilities**, not the size of one cell

Part

05

TEST YOUR JUDGMENT

Q14. In a survey, 120 of 144 cheap computers and 40 of 48 expensive ones needed repair in year one. Are cost and reliability associated?

ANSWER

No evidence of an association

Cheap: $120/144 = 5/6$. Expensive: $40/48 = 5/6$. The repair rates are identical, so cost tells us nothing about repairs.



Part

06

IS JUDGMENT REALLY SO POOR?

1. Criticisms of the biases research
2. What the wider evidence says
3. Frequencies are easier than probabilities
4. A practical method for probabilities

CRITICISMS OF THE BIASES RESEARCH

- Most experiments used **students**, who had no relevant expertise
- Tasks were often unfamiliar or artificial, unlike a manager judging a known market
- Some subjects may have read tasks as tests of real-world knowledge, not of statistics
- A **citation bias** exists: findings of poor performance were highlighted more than good performance

WHAT THE WIDER EVIDENCE SAYS

- Of 3,500 articles on judgment (1972-81), only **84** were empirical studies
- Of those, 47 reported poor performance and 37 reported good performance
- Experts with feedback can judge well in some domains
- Human judgment can add real value and sometimes **beats statistical methods**

Part

06

FREQUENCIES ARE EASIER THAN PROBABILITIES

The scenario

Gigerenzer argued that people think naturally in **frequencies**. When Linda-type problems ask "how many?" instead of "which is more probable?", errors against the conjunction law drop to under 25%.

What it shows

Ask for **counts out of 100** instead of abstract probabilities. Question format changes accuracy.

A PRACTICAL METHOD FOR PROBABILITIES

- 1 Find a reference class** Similar past events, or your own earlier forecasts
- 2 Use its frequency** How often did such events occur or succeed?
- 3 Otherwise be alert** If no class exists, know that heuristics may bias you

The authors advise locating a reference class before relying on gut feel.

**Judgment is neither hopeless nor perfect.
Knowing the biases is the first step to
managing them.**

Use data and reference classes when you can, and challenge your own estimates when you cannot.

KEY TAKEAWAYS

- **Availability:** vivid and recent events feel likelier than they are
- **Representativeness:** we ignore base rates, misread randomness, and fall for the conjunction fallacy
- **Anchoring:** we adjust too little, overrating conjunctive and underrating disjunctive events, and we are overconfident
- Wishful thinking and poor covariation judgment also distort models
- Frequency formats and reference classes improve estimates

KEY TERMS

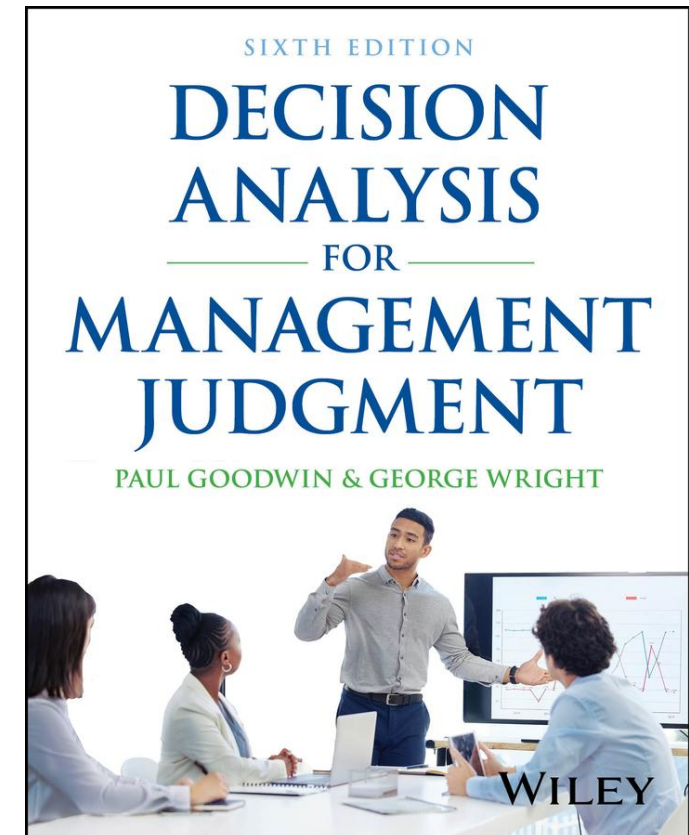
Term	Meaning
Heuristic	A simple mental shortcut for judgment
Base rate	How common something is in the population
Regression to the mean	Extreme results tend to be followed by more average ones
Conjunction fallacy	Rating A-and-B as likelier than A alone
Conjunctive / disjunctive	All must happen / at least one happens
Overconfidence	Ranges that are too narrow for the stated confidence

DISCUSSION QUESTIONS

- Which bias could most affect a project manager forecasting a completion date, and why?
- How would you brief a team to reduce anchoring in a budget meeting?
- When is a heuristic actually the smart choice?
- Design a quick quiz for classmates that shows the conjunction fallacy

REFERENCES

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2. Tversky, A. and Kahneman, D. (1974) Judgment under Uncertainty: Heuristics and Biases
3. Gigerenzer, G. on frequency formats and ecological rationality
4. Next in this series: Heuristics and Biases II, multi-objective choices (Chapter 2)





Thank You